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**Forest
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Southwestern
Region

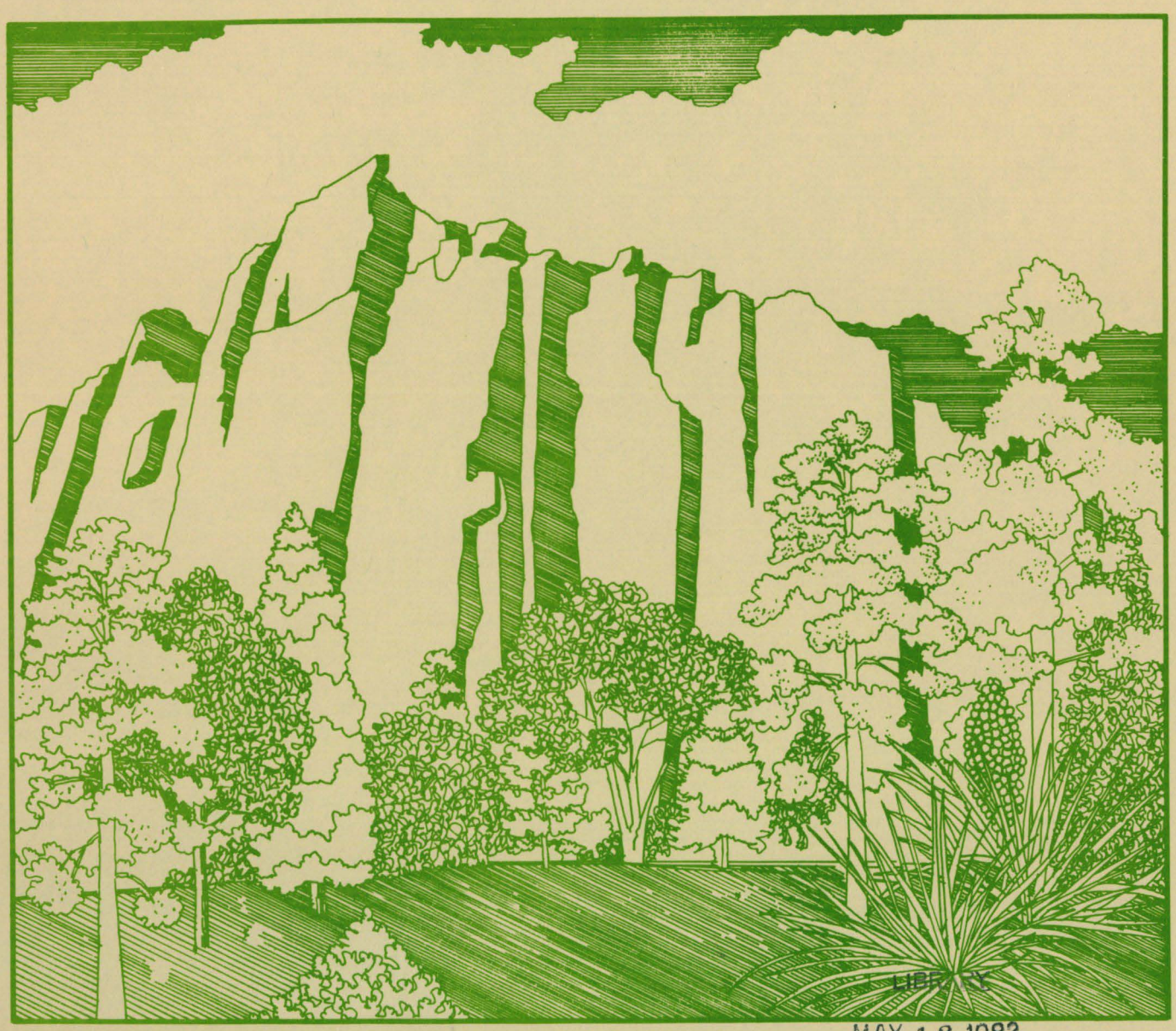
Forest Pest Management Report

R-3 82-6

BIOLOGICAL EVALUATION
Spruce Beetle

Fort Apache Indian Reservation
Arizona

March 1982



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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

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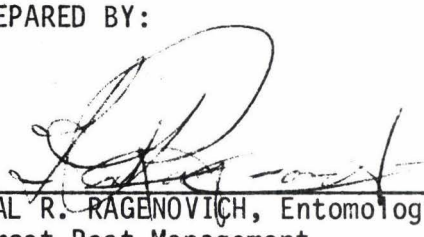

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INTRODUCTION

Several areas of extensive spruce beetle infestations were detected by Bureau of Indian Affairs, Division of Forestry, personnel in the spring of 1981 on the Fort Apache Indian Reservation in Arizona. Aerial detection surveys conducted in September showed areas of infestation throughout the spruce type. The largest infestation areas were located on Diamond Butte, Spruce Mountain, and Tiger Butte, and along the southern edge of the Mt. Baldy Wilderness Area. In the past, spruce beetle outbreaks have caused extensive losses in spruce on the Fort Apache Indian Reservation.

Ground surveys were conducted October 13-23 in a representative sample of the infested areas to obtain information on tree losses, green stand structure, and to determine the relative status of the spruce beetle populations. The data have been summarized and are presented in this evaluation, together with recommendations for spruce beetle and stand management.

TECHNICAL INFORMATION

Insect.--Spruce beetle, Dendroctonus rufipennis (Kirby)

Host.--Engelmann spruce, Picea engelmannii Parry

Life History and Evidence of Infestation (Furniss & Carolin 1977).--The spruce beetle generally has a 2-year life cycle. The adult attacks weakened or wind-thrown trees in the spring. Eggs hatch and larvae develop in the summer. They overwinter as half to nearly full-grown larvae and complete development the following year. New adults emerge in August and migrate to the base of the trees to overwinter.

Outbreaks are difficult to detect because the trees do not fade until a year after attack. The second year after attack, needles turn a pale green before falling off the tree. Pitch tubes are not always present; as a result, first-year attacks are sometimes only detected by the presence of brown boring dust around the base of the tree. The evidence of woodpecker activity is also an indication of attack.

During endemic years, the spruce beetle primarily attacks wind-thrown or weakened trees and stumps. Outbreaks are often caused by beetle populations building up in wind-thrown trees or logging debris, and spreading to standing trees. They will attack standing trees of all sizes, but prefer the large, overmature trees.

History of Spruce Beetle on the Fort Apache Indian Reservation (Lessard 1976).--Large areas of spruce mortality were first detected in the White Mountains of the Fort Apache Indian Reservation in 1904. This mortality was most likely the result of spruce beetle activity. The first reported spruce beetle outbreak occurred from 1948 to 1952, when an estimated 22 percent of the spruce was killed in the Ord Creek

drainage. The next recorded outbreak occurred from 1968 to 1971 when beetle populations built up in logging debris and spread to standing green trees, killing tens of thousands of trees in five drainages. The outbreak subsided abruptly in 1971 when record-low temperatures caused high larval mortality.

Location and Extent of the Current Infestation.--The current infestation was first detected in the spring of 1981. Major areas of infestation were: (1) from north of Tiger Butte southeast to and including Spruce Mountain, (2) Diamond Butte and several drainages east and south of Diamond Butte, (3) north of Mt. Ord, (4) several areas within the Mt. Baldy Wilderness Area, (5) an extensive area south of the southern wilderness boundary that extended from Bonito Creek northeast to Peasoup Creek, and (6) Sunrise Ski Area. Figure 1 shows the locations of the infestations as detected during the aerial detection survey conducted in August and September of 1981. Based on aerial surveys, the total infested area is estimated at about 10,000 acres. There were an estimated 6,000 fading trees in the Tiger Butte-Spruce Mountain infestation, 2,000 fading trees in the Diamond Butte infestation, and 5,000 fading trees in the area south of the Mt. Baldy Wilderness. The estimated number of dead trees reported during the aerial survey is used as an indicator for the location and size of an infestation and is not the actual number of trees attacked since trees attacked in the current year are still green and only detectable during a ground survey. Salvage logging was initiated in the Tiger Butte-Spruce Mountain area during the summer of 1981. Some infested areas are located near or adjacent to areas that had been logged or new road construction.

METHODS

Survey Areas.--The infestations are scattered throughout an extensive (11-mile square) area of spruce and spruce-fir type around and including the Mt. Baldy Wilderness Area. Due to the extent of the entire spruce type, eight infested areas were selected for sampling. Survey areas were selected on the basis of size, distribution, access, and management importance. Survey areas are: (1) Diamond Butte, (2) Moon Creek, (3) Sun Creek, (4) Bonito Creek, (5) Sunrise Creek, (6) Loafer Mountain, (7) Mt. Ord, and (8) Mt. Baldy Wilderness. Figure 2 shows the location and approximate boundaries of each of these survey areas.

Data Collection.--Surveys were conducted according to procedures outlined by Acciavatti, Schmid, and Cahill in the Forest Insect and Disease Survey Methods Manual. Information for the number of currently infested and uninfested green trees was obtained on a combination strip and variable plot cruise. Data collected on the strip cruise would indicate the number, size by diameter class, and distribution of infested trees. Data collected on the variable plots would provide information on the green stand and the susceptibility of that stand.

Survey lines were oriented to cover the infested area and established 10 chains apart. Along the survey lines, two- or three-man crews ran strip plots end to end with variable plots spaced at 10-chain intervals along the line. Most strip plots were 1/2 chain by 10 chains (.5 acre). Some sample plots were 1/2 chain by 15 chains (.75 acres). Lines were established by hand compass and pacing. All infested trees over 5 inches d.b.h. that fell within 16.5 feet of either side of the cruise line were recorded by 1-inch diameter classes and classified according to these criteria: (1) new--current year's attack, green foliage; (2) old--previous year's attack, fading foliage, hibernating adults in the lower bole; (3) snag--infested over 2 years ago, evidence of previous attack but no beetles present; (4) pitchout--unsuccessful attacks of the current year; (5) strip attack--partially attacked tree with attacks concentrated on one side; and (6) windthrown--down trees with yellow or green foliage and spruce beetles present.

Green, live trees were tallied on variable radius plots (20 BAF) located at the center of each strip plot. A Spiegel Relaskop was used to measure the critical angle from each plot center. Trees larger than 5 inches d.b.h. were tallied by species and 1-inch diameter class and damage.

The relative vigor and abundance of spruce beetle broods within infested trees were also noted in each survey area.

Data Analysis.--Data for estimating tree loss on the strip cruise plots were analyzed by the "INDIDS" (Insect and Disease Damage Survey) program (Bousfield 1980). These data will provide information on number of trees per acre and volume of infested trees in each damage class for each area. Volumes were figured with average diameter and height tables for the Ft. Apache Indian Reservation, and using Kemp's equations for volume.

The variable plot data were also analyzed in the INDIDS program for basal area of the host type and percent basal area and volume of damaged trees.

RESULTS AND DISCUSSION

Tree Losses

The ground survey data on tree losses in each area are presented in table 1. The number of currently infested trees for the sample areas were: Bonito Creek, 4.9; Diamond Butte, 5.1; Mt. Ord, 10.2; Sun Creek, 4.1; Mt. Baldy Wilderness, 7.2; Sunrise, 1.8; Loafer, 1.8; and Moon Creek, 1.6. Although Sunrise, Loafer, and Moon Creek areas had a low number of currently infested trees per acre, these levels are still considered as a level of light infestation.[1/] In the 8 areas

1/ Personal communication, John Schmid, Rocky Mountain Forest and Range Experiment Station.

sampled, with a combined total of 4,000 acres, there was an estimated 16,700 trees attacked by spruce beetle in 1981. This represents approximately 1,341.7 MCF of timber killed in 1981. Table 2 shows the estimated numbers of trees and volume loss in each damage class for each area.

Of the currently attacked and previous years' attacked trees, 73 percent were over 17 inches d.b.h. and 60 percent were over 19 inches d.b.h. Schmid and Frye (1977) found this to be the case, where large diameter standing trees were preferred to smaller diameter standing trees. This is also evident in table 3 which shows the mean diameter of trees in each area by damage class. In all areas, except the Loafer sample area, the mean diameter of currently attacked and previous years' attacked trees is much larger than the mean diameter of the remaining undamaged spruce.

Wind-thrown trees were recorded in five of the sample areas: Bonito Creek, Diamond Butte, Sun Creek, Moon Creek, and Mt. Baldy Wilderness. In 4 areas, the number of wind-thrown trees ranged from less than 1 to 3 trees per 10 acres. This amount of windthrow would be enough to sustain an endemic population of beetles (cited in Schmid and Frye 1977). In the Sun Creek sample area, there were 1.2 downed infested trees per acre. These trees were not actually wind-thrown, but had been cut for a road right-of-way in 1981, and were left to serve as trap trees which will be removed in 1982. However, since these trees would serve the same purpose as wind-thrown trees for this evaluation, they were included in that category.

Older attacked trees were trees that had been attacked and killed by spruce beetle 1 to 3 years prior to last year's attacks. The number of older attacked trees indicates that spruce beetles had been killing spruce in these areas for a number of years prior to when the infestation was first detected.

Most major outbreaks are a result of stand disturbances such as blowdown or logging debris (cited in Schmid and Frye 1977). Over the past several years, an extensive amount of cutting for road rights-of-way and timber harvesting has been done throughout the spruce type. A combination of logging and right-of-way slash, as well as blowdown in recently opened stands, has contributed to the current outbreak. The susceptibility of the green stand is also an important factor.

Green Stand Structure

Information on green stand structure was obtained from the variable plot data. Table 4 presents the basal area for each survey area and the percent of that basal area of each species. Basal areas ranged from 151 in the Sun Creek area to 272 on the Mt. Ord area. Except for the Moon Creek drainage, all sample areas are primarily spruce, ranging from 67 to 98 percent of the basal area of the stand being spruce. The percent of spruce in terms of trees per acre is somewhat higher.

Stands can be characterized for their susceptibility to spruce beetle attacks based on stand structure (Schmid and Hinds 1974, Schmid and Frye 1976; Schmid and Frye 1977). They describe unmanaged stands as having the following characteristics: (1) an average diameter at breast height of over 16 inches, (2) a basal area of more than 150 square feet per acre, (3) more than 65 percent spruce in the canopy, and (4) located in a well-drained creek bottom.

The survey areas for the most part meet these requirements. Since there are active infestations in these highly susceptible areas, the infestation is expected to continue to increase.

Spruce Beetle Populations

Visual observations were made on the condition of spruce beetle brood and adult beetles in currently infested and previous years' attacked trees. Larvae in currently infested trees appeared healthy. Hibernating adults were common at the base of trees attacked the previous year. These adults will emerge and attack adjacent trees in the spring of 1982.

CONCLUSIONS

The current spruce beetle infestation on the Fort Apache Indian Reservation will continue to cause significant spruce mortality as indicated by the high population levels and the susceptibility of the stands examined. Data indicate that the infestation has existed in these areas for a number of years. Results from stand disturbances may have provided opportunity for increased populations. These are residuals left from logging activity, trees cut for road rights-of-way, and blowdown from opened stands.

ALTERNATIVES

The following alternatives for managing a spruce beetle infestation are available:

1. No action. This alternative would allow the infestation to continue and accept the losses incurred until the infestation collapses naturally.

2. Direct suppression. This alternative would involve individual tree treatment. This treatment could be through removal of infested trees, treating them with a chemical insecticide, or by felling and burning. Individual tree treatment is often expensive and effective only in small infestations. Chemically treated trees could be salvaged at a later date.

3. Sanitation logging. In this alternative, susceptible green trees would be removed from the stand on a selective basis. This would remove the large diameter trees and reduce the basal area of the

stand by changing the green stand structure. This alternative would not be effective by itself in an already infested stand; however, sanitation logging could be used to reduce the susceptibility of an uninfested stand.

4. Salvage logging. Both currently infested trees and dead trees would be removed. This alternative would utilize the timber resource, as well as suppress the infestation. However, in large areas of infestation, this action may not be practical. This type of logging would not change the factors in the stand causing the outbreak.

5. Sanitation/salvage logging. This alternative combines the removal of dead and infested trees, and the susceptible uninfested trees in a stand. This would allow utilization of the timber resource and change the stand structure to reduce the susceptibility of the stand. In extensive areas of infestation, this alternative may not be practical.

6. Trap-tree method. Attempts have been made to use trap trees as a means of beetle control. It involves felling uninfested green trees around an infestation. The beetles will attack available down material. In large infestations, this method may not control a population, but it would remove beetles that might otherwise attack other standing trees. Large, merchantable trees would be cut in the fall or in the spring before beetle flight. Trees should be felled in shaded area, but not on moist sites where they will sink into any mud; the limbs should be left uncut. Once the trap trees have been attacked, they should be removed from the stand within 1 year of date of felling. Trap trees should be cut within 1/4 mile of an accessible road.

A variation of the trap trees is the lethal trap tree which incorporates the use of cacodylic acid. Trap trees are treated with cacodylic acid, then cut. The cacodylic acid provides an unfavorable environment for the brood and they die before completing development. This method would not require the removal of trap trees within a certain time period.

RECOMMENDATIONS

Short-term Action. From an entomological standpoint, there is little that can be done to suppress the entire infestation. This is because of the extent of the infestations and the susceptibility of the remaining uninfested stands. The inaccessibility of some areas also limits the actions that can be taken against the infestation.

Recommended actions are as follows:

1. The extent of the infestation, as well as economic and physical constraints, would not allow effective treatment of the

entire infestation, therefore; the infested areas should be prioritized according to value and management objectives in order to effectively utilize the available resources.

2. Depending on priority in areas such as the Diamond Butte, Bonito Creek, and Mt. Ord survey units, the sanitation/salvage alternative is recommended. This would involve a one-time entry into the stands to remove infested and susceptible, uninfested trees without affecting the windfirmness of the stand and conform to stand prescriptions.

3. A no action alternative is recommended for areas of low priority, where management objectives, economics, or accessibility do not permit a suppression program. Losses from the spruce beetle will have to be accepted with this alternative.

4. In some situations, for instance where a sanitation/salvage program is planned, trap trees could be felled within the infestation area. Trap trees would not suppress the infestation, but would attract many beetles that might otherwise attack standing green trees. Trees should be felled in areas that are accessible, since it would be essential that they be removed within 1 year of the date of felling.

Trees cut for road rights-of-way or other logging activity or windthrow in infested areas can be left for trap trees for 1 year. If these trees occur in areas where no infested trees area nearby, they must be removed as they will only serve to draw beetles into a previously uninfested area.

Long-term Action. The potential for future spruce beetle infestations can be reduced by modifying management of spruce-fir stands. Hazard rating should be done to determine the susceptibility of uninfested stands and priorities established on the stands. Managing these stands would involve sanitation logging to convert stands to a less susceptible condition by removing large diameter, overmature trees and reducing the basal area of the stand. Thereafter, group selection and/or patch, strip, or stand clearcutting should be conducted to maintain this stand condition. If blowdown occurs, the infested material should be removed promptly.

To prevent population buildups and subsequent outbreaks in all harvesting and cutting operations, including normal timber harvest of spruce, sanitation/salvage cutting, or cutting for road rights-of-way and construction, all slash and butt logs should be treated in a proper manner.

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APPENDIX

Figure 1.--Location of spruce beetle infestation on the Ft. Apache Indian Reservation, as detected during 1981 aerial survey.

Figure 2.--Location and approximate size of western spruce beetle survey areas on the Ft. Apache Indian Reservation.

TABLE 1.--Trees per acre, basal area, and estimated cubic feet per acre by damage class of spruce beetle damage on sample areas on the Ft. Apache Indian Reservation, 1981

BONITO CREEK

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	.1	0	0	0	0	.1
7-8.9	TA	0	0	.1	.1	0	0	.2
	BA	0	0	0	0	0	0	0
	CFA	.1	.1	.5	.2	.2	.1	1.2
9-10.9	TA	.1	.1	.3	.3	0	0	.8
	BA	.1	0	.1	.1	0	0	.3
	CFA	1.0	.8	2.6	3.1	0	0	7.5
11-12.9	TA	.3	.1	.3	.4	.1	0	1.2
	BA	.2	.1	.3	.2	.1	0	.9
	CFA	5.1	1.4	6.3	5.9	1.7	0	20.4
13-14.9	TA	.2	.3	.4	.8	.2	0	1.9
	BA	.2	.3	.4	.8	.2	0	1.9
	CFA	5.7	6.4	11.9	21.9	3.2	0	49.1
15-16.9	TA	.6	.3	.3	1.0	.1	0	2.3
	BA	.9	.4	.4	1.3	.1	0	3.1
	CFA	26.6	10.7	13.6	40.0	2.6	1.1	94.6
17-18.9	TA	.8	.2	.2	1.1	.1	0	2.4
	BA	1.3	.3	.4	1.8	.2	.1	4.1
	CFA	43.4	9.3	13.7	58.8	5.7	1.3	132.2
19+	TA	2.9	.7	1.3	1.6	.3	0	6.8
	BA	8.8	2.5	4.1	4.8	.8	.1	21.1
	CFA	350.9	99.1	155.8	197.6	34.4	1.8	839.6
TOTALS	TA	4.9	1.7	2.9	5.3	.8	0	15.6
	BA	11.5	3.6	5.7	9.0	1.4	.2	31.4
	CFA	432.8	127.9	204.4	327.5	47.8	4.3	1,144.7

TA = trees per acre
BA = basal area
CFA = cubic feet per acre

TABLE 1 (cont'd.)

SUNRISE

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	.1	0	0	0	.1
7-8.9	TA	0	0	.1	.1	0	0	.2
	BA	0	0	0	0	0	0	0
	CFA	.2	.2	.7	.5	0	0	1.6
9-10.9	TA	0	0	.5	.1	0	0	.6
	BA	0	0	.3	.1	0	0	.4
	CFA	0	0	5.3	1.2	.4	0	6.9
11-12.9	TA	0	0	.6	.3	.1	0	1.0
	BA	0	0	.4	.2	.1	0	.7
	CFA	.6	.7	12.1	5.4	1.3	0	20.1
13-14.9	TA	.3	.1	.9	.3	0	0	1.6
	BA	.3	.1	.9	.3	0	0	1.6
	CFA	7.5	2.5	22.9	8.6	.9	0	42.4
15-16.9	TA	.4	.2	.8	.2	.1	0	1.7
	BA	.6	.3	1.0	.3	.2	0	2.4
	CFA	17.8	7.5	28.2	10.4	3.9	0	67.8
17-18.9	TA	.3	.1	.5	.4	.2	0	1.5
	BA	.5	.1	.8	.6	.3	0	2.3
	CFA	15.8	5.5	27.1	19.2	10.8	0	78.4
19+	TA	.8	.3	1.6	.4	.1	0	3.2
	BA	2.6	1.0	4.8	1.0	.2	0	9.6
	CFA	101.1	41.9	192.5	42.1	9.7	0	387.3
TOTALS	TA	1.8	.7	5.0	1.8	.5	0	9.8
	BA	4.0	1.5	8.2	2.5	.8	0	17.0
	CFA	143.0	58.3	288.8	87.4	27.1	0	604.6

TABLE 1 (cont'd.)

DIAMOND BUTTE

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
7-8.9	TA	.2	0	.4	.3	0	0	.9
	BA	.1	0	.1	.1	0	0	.3
	CFA	1.0	.1	2.0	1.7	0	0	4.8
9-10.9	TA	.2	.1	.7	.5	.2	0	1.7
	BA	.1	0	.3	.2	.1	0	.7
	CFA	2.1	1.2	6.9	5.4	1.8	0	17.4
11-12.9	TA	.1	.2	.7	.3	.2	0	1.5
	BA	.1	.1	.5	.2	.1	0	1.0
	CFA	2.7	3.8	25.4	5.6	3.4	0	40.9
13-14.9	TA	.3	.2	1.2	.5	0	0	2.2
	BA	.4	.2	1.2	.5	0	0	2.3
	CFA	7.3	4.3	19.9	13.0	.9	0	45.4
15-16.9	TA	.6	.3	1.4	.9	.1	0	3.3
	BA	.8	.3	1.9	1.1	.1	0	4.2
	CFA	23.2	10.5	37.9	33.3	5.5	0	110.4
17-18.9	TA	.4	.4	1.2	.8	.2	0	3.0
	BA	.7	.7	2.1	1.3	.3	0	5.1
	CFA	23.1	23.3	50.3	43.4	9.2	0	149.3
19+	TA	3.3	3.4	2.7	2.1	.8	.1	12.4
	BA	11.3	11.7	8.7	5.6	2.4	.2	39.9
	CFA	465.8	476.3	291.8	223.8	96.1	5.4	1,559.2
TOTALS	TA	5.1	4.6	8.3	5.4	1.5	.1	25.0
	BA	13.5	13.0	14.8	9.0	3.0	.2	53.5
	CFA	525.2	519.5	434.2	326.2	116.9	5.4	1,927.4

TABLE 1 (cont'd.)

MT. ORD

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
7-8.9	TA	0	0	0	.3	0	0	.3
	BA	0	0	0	.1	0	0	.1
	CFA	0	0	0	1.7	0	0	1.7
9-10.9	TA	0	0	.5	1.3	0	0	1.7
	BA	0	0	.3	.7	0	0	.9
	CFA	0	0	6.0	14.4	0	0	20.4
11-12.9	TA	.5	0	.5	2.2	.3	0	3.5
	BA	.4	0	.4	1.7	.2	0	2.7
	CFA	10.3	0	9.2	44.0	5.1	0	68.6
13-14.9	TA	2.0	.8	.3	2.7	.3	0	6.0
	BA	2.1	.8	.2	2.8	.2	0	6.1
	CFA	54.0	19.9	6.0	73.8	6.0	0	159.7
15-16.9	TA	1.0	.5	.8	2.2	.5	0	5.0
	BA	1.3	.7	1.0	3.0	.6	0	6.5
	CFA	37.8	19.8	29.1	89.8	17.8	0	194.4
17-18.9	TA	1.5	.3	0	1.0	.3	0	3.0
	BA	2.5	.4	0	1.7	.4	0	5.1
	CFA	82.0	14.7	0	54.6	14.7	0	166.0
19+	TA	5.2	3.0	.5	2.7	.5	0	12.0
	BA	13.7	8.9	1.8	6.7	1.3	0	32.4
	CFA	549.4	372.1	76.6	277.1	55.1	0	1,330.2
TOTALS	TA	10.2	4.5	2.5	12.5	1.7	0	31.5
	BA	20.0	10.8	3.6	16.6	2.7	0	53.8
	CFA	733.4	426.5	126.9	555.5	98.7	0	1,940.9

TABLE 1 (cont'd.)

LOAFER

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
7-8.9	TA	0	0	0	.2	0	0	.2
	BA	0	0	0	.1	0	0	.1
	CFA	0	0	0	1.1	0	0	1.1
9-10.9	TA	.2	0	0	0	0	0	.2
	BA	.1	0	0	0	0	0	.1
	CFA	1.5	0	0	0	0	0	1.5
11-12.9	TA	0	.2	.2	.3	0	0	.7
	BA	0	.1	.1	.2	0	0	.5
	CFA	0	2.7	3.4	5.4	0	0	11.6
13-14.9	TA	0	.2	0	.8	.2	0	1.2
	BA	0	.2	0	.8	.2	0	1.2
	CFA	0	4.6	0	21.2	4.0	0	29.9
15-16.9	TA	0	0	.5	.2	0	0	.7
	BA	0	0	.6	.2	0	0	.8
	CFA	0	0	19.2	5.3	0	0	24.5
17-18.9	TA	.2	.2	.3	.3	0	0	1.0
	BA	.3	.3	.6	.6	0	0	1.7
	CFA	8.5	8.4	19.6	18.2	0	0	54.8
19+	TA	1.5	1.0	1.2	1.5	0	0	5.2
	BA	4.3	3.5	3.1	4.3	0	0	15.3
	CFA	178.4	150.6	118.7	175.7	0	0	623.3
TOTALS	TA	1.8	1.5	2.2	3.3	.2	0	9.0
	BA	4.6	4.1	4.5	6.2	.2	0	19.5
	CFA	188.4	166.4	160.9	227.0	4.0	0	746.6

TABLE 1 (cont'd.)

SUN CREEK

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	.1	.1	0	0	.2
	BA	0	0	0	0	0	0	0
	CFA	0	0	.2	.2	0	0	.4
7-8.9	TA	.1	0	.2	0	0	0	.3
	BA	0	0	.1	0	0	0	.1
	CFA	.6	0	1.3	0	0	0	1.9
9-10.9	TA	.2	0	.4	.2	0	.2	1.0
	BA	.1	0	.2	.1	0	.1	.5
	CFA	1.8	0	4.1	2.3	0	2.3	10.4
11-12.9	TA	.1	0	.5	.2	.1	0	.8
	BA	.1	0	.3	.1	.1	0	.5
	CFA	1.6	0	7.8	3.4	2.3	0	12.8
13-14.9	TA	.2	0	.5	.5	.1	.1	1.3
	BA	.2	0	.5	.5	.1	.1	1.3
	CFA	5.3	0	12.1	12.9	3.3	2.3	34.8
15-16.9	TA	.6	.1	1.0	.3	.2	0	2.1
	BA	.7	.1	1.3	.4	.3	0	2.7
	CFA	21.5	4.2	38.9	10.8	9.8	0	78.7
17-18.9	TA	.6	.1	.6	0	.2	.1	1.5
	BA	1.0	.2	.9	0	.3	.2	2.5
	CFA	31.2	4.8	29.7	0	9.8	4.8	80.4
19+	TA	2.4	.7	1.3	.8	.4	.9	6.4
	BA	7.2	2.3	4.2	1.9	1.1	3.3	20.0
	CFA	281.7	91.4	169.8	76.5	47.1	130.6	797.1
TOTALS	TA	4.1	.9	4.6	2.0	.8	1.2	13.5
	BA	9.3	2.6	7.5	3.0	1.6	3.7	27.7
	CFA	343.7	100.4	263.9	106.0	62.5	139.9	1,016.5

TABLE 1 (cont'd.)

MOON CREEK

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
7-8.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
9-10.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
11-12.9	TA	0	0	.2	0	0	0	.2
	BA	0	0	.1	0	0	0	.1
	CFA	0	0	3.7	0	0	0	3.7
13-14.9	TA	0	0	.5	.2	0	0	.7
	BA	0	0	.6	.2	0	0	.8
	CFA	0	0	15.1	5.0	0	0	20.2
15-16.9	TA	.2	.2	.4	0	0	0	.7
	BA	.3	.2	.5	0	0	0	1.0
	CFA	8.0	6.3	14.3	0	0	0	28.5
17-18.9	TA	0	.2	.9	0	0	0	1.1
	BA	0	.3	1.5	0	0	0	1.8
	CFA	0	9.2	50.4	0	0	0	59.6
19+	TA	1.5	2.2	1.8	.7	.5	.2	6.9
	BA	4.1	7.8	5.5	2.0	1.7	.6	21.7
	CFA	164.8	308.7	219.6	84.4	68.3	25.0	870.7
TOTALS	TA	1.6	2.5	3.8	.9	.5	.2	9.6
	BA	4.4	8.3	8.3	2.2	1.7	.6	25.4
	CFA	172.8	324.2	303.1	89.4	68.3	25.0	982.8

TABLE 1 (cont'd.)

MT. BALDY WILDERNESS

Diameter class		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
5-6.9	TA	0	0	0	0	0	0	0
	BA	0	0	0	0	0	0	0
	CFA	0	0	0	0	0	0	0
7-8.9	TA	.1	0	.3	0	0	0	.4
	BA	0	0	.1	0	0	0	.1
	CFA	.9	0	1.1	0	0	0	2.0
9-10.9	TA	.1	0	.1	.1	.1	0	.5
	BA	.1	0	.1	.1	.1	0	.3
	CFA	1.6	0	1.2	1.6	1.2	0	5.7
11-12.9	TA	.4	0	0	.9	.1	0	1.5
	BA	.3	0	0	.7	.1	0	1.1
	CFA	7.1	0	0	17.4	2.7	0	27.3
13-14.9	TA	.4	.1	.3	1.6	.4	0	2.8
	BA	.4	.1	.3	1.6	.4	0	2.9
	CFA	10.6	3.2	7.4	42.4	11.1	0	74.7
15-16.9	TA	1.2	.4	.4	1.3	.1	0	3.5
	BA	1.5	.5	.5	1.8	.2	0	4.5
	CFA	46.5	16.3	14.5	53.9	5.8	0	137.1
17-18.9	TA	1.6	.3	.9	1.5	.1	0	4.4
	BA	2.7	.4	1.5	2.5	.2	0	7.4
	CFA	87.4	13.5	50.5	82.9	7.8	0	242.1
19+	TA	3.3	.9	2.0	2.3	.7	.3	9.5
	BA	9.4	2.6	5.2	6.4	2.0	.8	26.4
	CFA	376.1	109.1	216.0	262.7	83.0	31.6	1,078.5
TOTALS	TA	7.2	1.7	4.0	7.7	1.6	.3	22.5
	BA	14.4	3.7	7.6	13.1	3.0	.8	42.6
	CFA	530.2	142.0	290.7	461.0	111.7	31.6	1,567.3

TABLE 2.--Estimated volume loss of spruce by damage class for each survey area, Ft. Apache Indian Reservation, 1981

Survey area	Size (acres)		Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack	Wind-throw	Stand total
Bonito Creek	1,400	# trees	6,860	2,380	4,060	7,420	1,120	---	21,840
		MCF	605.9	179.1	286.2	458.5	66.9	6.0	1,602.6
Sunrise	1,000	# trees	1,800	700	5,000	1,800	500	---	9,800
		MCF	25.5	10.4	51.6	15.6	4.8	---	107.9
Diamond Butte	600	# trees	3,060	2,760	4,980	3,240	900	60	15,000
		MCF	315.1	311.7	260.5	195.7	70.1	3.2	1,153.1
Mt. Ord	200	# trees	2,040	900	500	2,500	340	---	6,280
		MCF	146.7	85.3	25.4	111.1	19.7	---	388.2
Loafer	300	# trees	540	450	660	990	60	---	2,700
		MCF	56.5	49.9	48.3	68.1	1.2	---	224.0
Sun Creek	200	# trees	820	180	920	400	160	240	2,720
		MCF	68.7	20.1	52.8	21.1	12.5	28.0	203.3
Moon Creek	100	# trees	160	250	380	90	50	20	950
		MCF	17.3	32.4	30.3	8.9	6.8	2.5	98.2
Mt. Baldy Wilderness	200	# trees	1,440	340	1,200	2,310	480	90	5,860
		MCF	106.0	42.6	87.2	138.3	33.5	9.5	417.1
TOTAL	4,000	# trees	16,720	7,960	17,700	18,750	3,610	410	65,150
		MCF	1,341.7	731.5	842.3	1,017.4	215.5	49.2	4,194.4

TABLE 3.--Percent of spruce damaged by spruce beetle by damage class, Ft. Apache Indian Reservation, 1981

Survey area		% Damage classes					
		Undamaged	Current attack	Last year's attack	Older attack	Unsuccessful attack	Strip attack
Bonito Creek	% spruce (TA)[1/]	80.4	4.8	.6	4.9	6.8	2.4
	mean diameter[2/] (inches)	12.7	19.3	20.3	15.3	15.2	15.5
Sunrise	% spruce (TA)	87.9	2.2	.4	7.5	1.5	.5
	mean diameter (inches)	12.2	15.3	19.5	14.5	16.1	18.8
Diamond Butte	% spruce (TA)	71.4	5.2	2.2	10.7	10.0	.5
	mean diameter (inches)	14.3	21.1	23.2	16.4	16.1	22.7
Mt. Ord	% spruce (TA)	91.4	3.8	.2	1.1	2.8	.6
	mean diameter (inches)	11.1	19.7	24.0	15.3	19.7	21.5
Loafer	% spruce (TA)	78.9	6.9	1.6	3.1	9.1	0
	mean diameter (inches)	16.1	13.7	22.9	20.4	19.5	0
Sun Creek	% spruce (TA)	96.0	1.4	0	2.1	.4	0
	mean diameter (inches)	10.1	22.7	0	17.4	16.0	0
Moon Creek	% spruce (TA)	75.4	3.2	4.8	11.4	2.9	2.1
	mean diameter (inches)	15.4	24.3	23.0	16.6	20.9	24.1
Mt. Baldy Wilderness	% spruce (TA)	92.6	2.3	0	0	4.6	.3
	mean diameter (inches)	14.0	16.7	0	0	15.5	20.0

1/ TA = trees/acre
2/ Mean diameter is diameter of tree of mean basal area.

TABLE 4.--Total basal area and basal area by species of survey areas on Ft. Apache Indian Reservation, 1981

Survey area	Total basal area of stand	% basal area by species				
		Spruce	True fir	Douglas-fir	Aspen	White pine
Bonito Creek	151.9	67.2	12.0	15.3	5.3	.2
Sunrise	186.9	73.1	19.2	4.2	3.5	0
Diamond Butte	193.8	89.9	8.5	1.6	0	0
Mt. Ord	272.5	98.2	1.8	0	0	0
Loafer	208.9	67.0	19.1	6.4	7.4	0
Sun Creek	151.4	76.7	18.9	.6	3.8	0
Moon Creek	189.1	42.3	55.8	1.9	0	0
Mt. Baldy Wilderness	208.0	79.5	14.7	5.1	.6	0